

g-LIMIT Science Overview



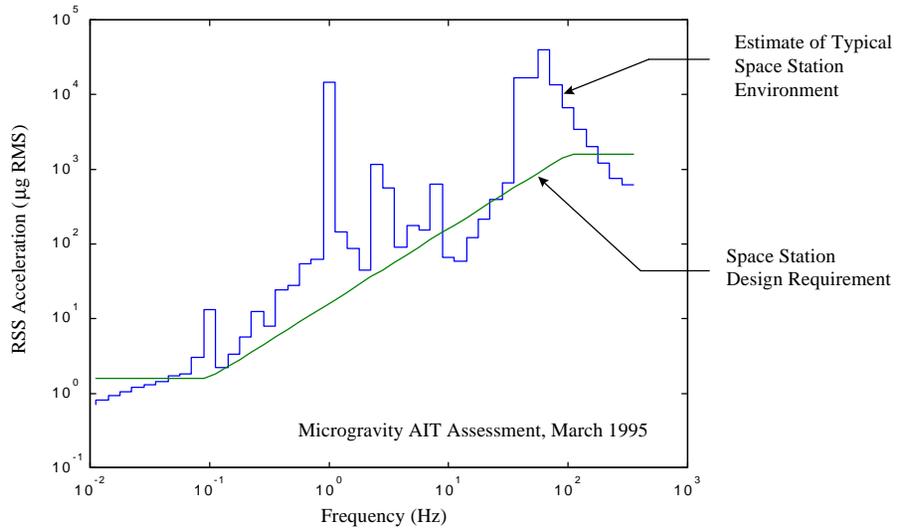
Dr. Mark Whorton
g-LIMIT Principal Investigator
NASA Marshall Space Flight Center

PR IV Kick-Off
June 5, 2000

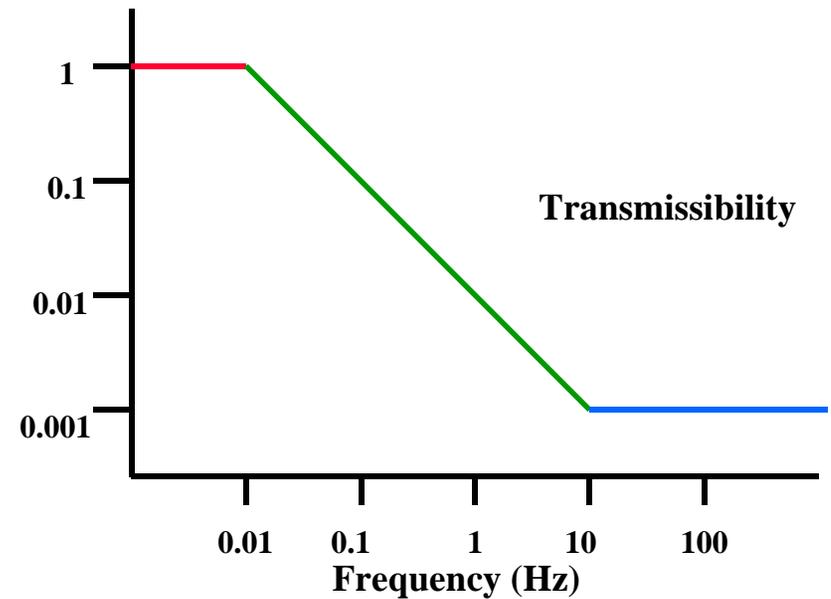
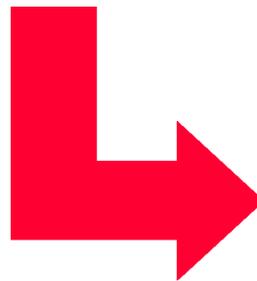
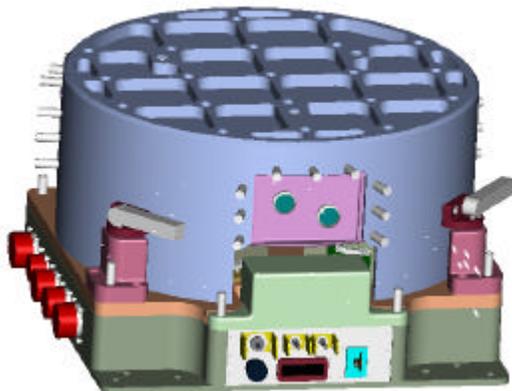


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Why is Vibration Isolation Necessary for ISS?



G-LIMIT is a microgravity
vibration isolation system
for the MSG



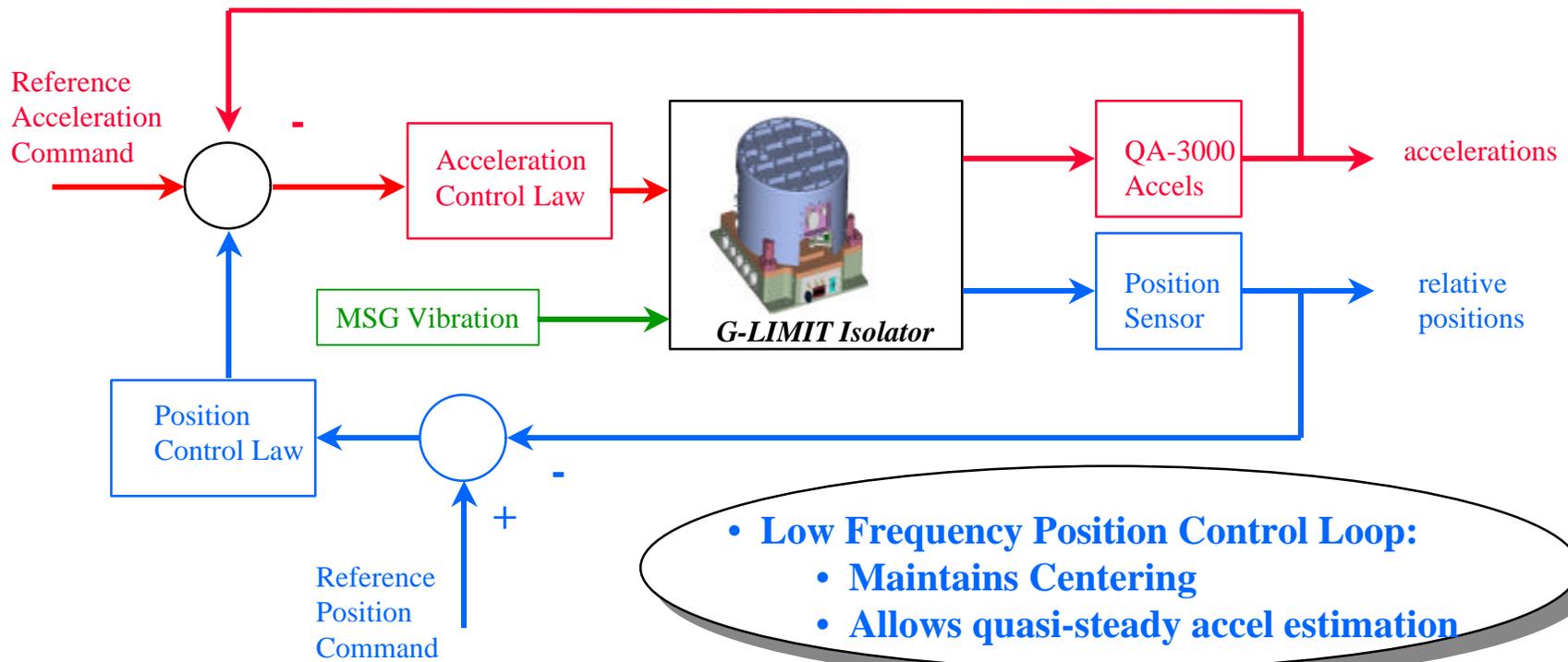


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How Does g-LIMIT Isolate from Vibrations?



- **High Frequency Acceleration Control Loop:**
 - Cancels Inertial Motion of the Platform
 - Allows “Good Vibrations”



- **Low Frequency Position Control Loop:**
 - Maintains Centering
 - Allows quasi-steady accel estimation



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Control Modes



- Control Modes:

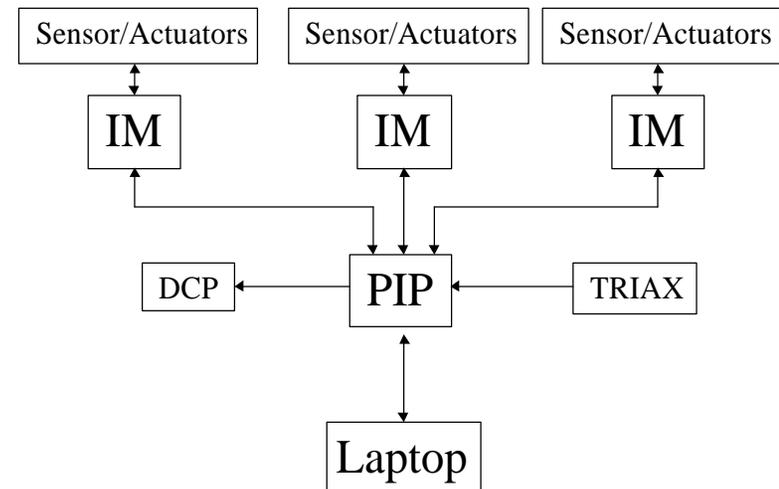
- » Passive
- » Standby
- » Active

- Implementation:

- » Central
- » Local -- *not implemented for C.T*

- Architectures:

- » Classical (SISO)
- » Multivariable (MIMO)

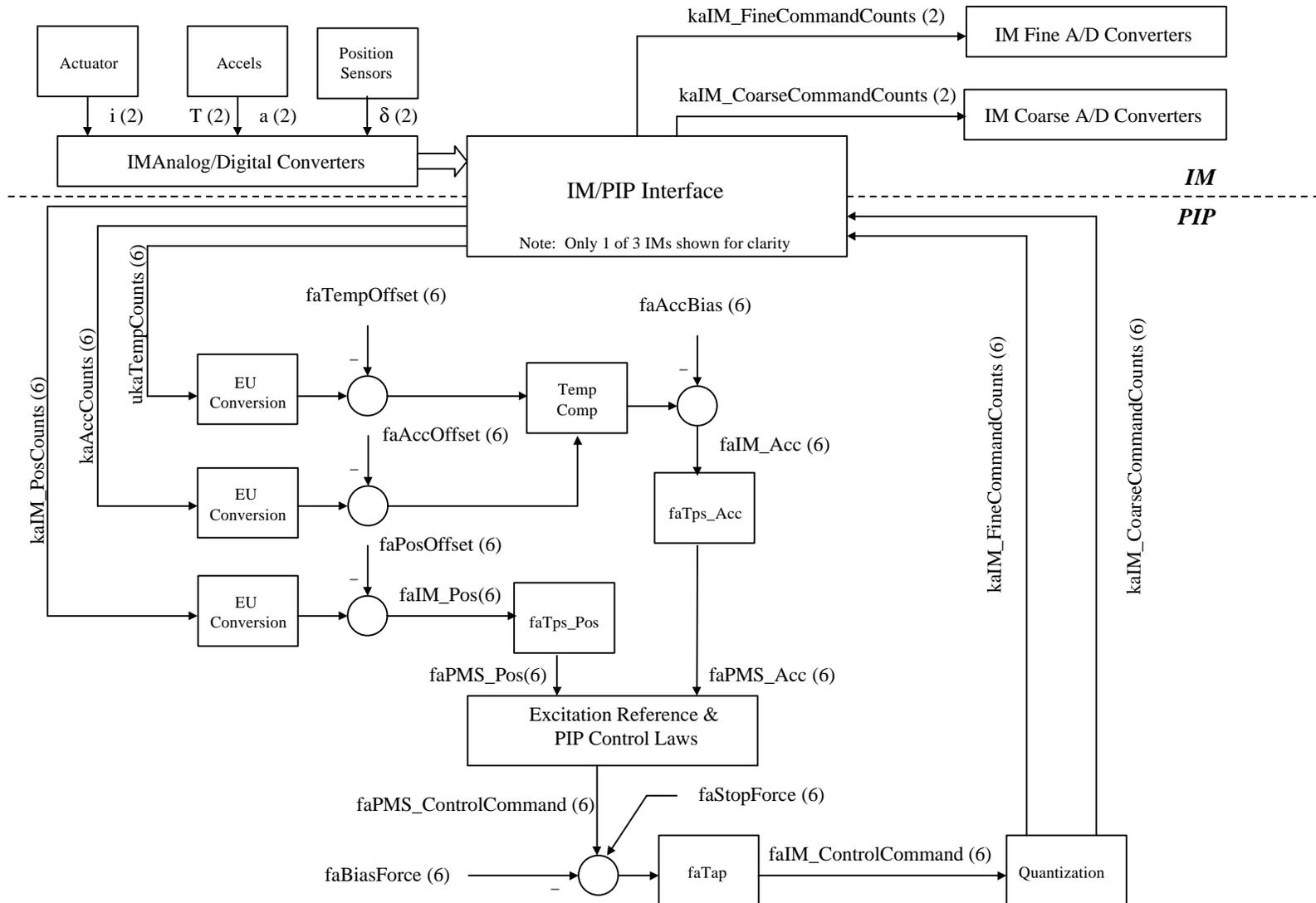


Distributed
Architecture



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g-LIMIT Control Block Diagram





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Control Modes



- **Control Modes:**

- » Passive
- » Standby- Position Feedback Only
- » Active - Position & Acceleration Feedback

- **Architectures:**

- » Classical (SISO)
- » Multivariable (MIMO)

Mode Class	No.	Mode ID	Description
Passive Control Mode			
	1	PAS	Passive Mode
Standby Control Modes			
	2	LSS	Local SISO
	3	CSS	Central SISO
Active Control Modes			
	4	LSA	Local SISO
	5	DMA	Decoupled MIMO
	6	CSA	Central SISO
	7	CMA	Central MIMO



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Characterization Test Data Management



- Characterization data for each test will be archived on orbit
 - » 440 MB PCMCIA Flash Disk used for mass data storage
 - » Requires daily crew change-out
 - » A log file will be created for each test
 - » Daily archival data downlink via medium rate telemetry
- Two sample rates implemented:
 - » Major frame sampled at 500 kHz, 8 pole filter at 125 Hz
 - » Minor frame sampled at 25 Hz, 4 filter poles at 6.25 Hz
- Real-time low rate data displayed on crew laptop and downlinked via 1553



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Characterization Test Requirements



- R1: Provide attenuation of MSG induced accelerations
- R2: Generate user-specified pristine excitations to payload.
- R3: Evaluate capability to measure quasi-steady accelerations from control law.
- R4: Evaluate advanced vibration control technology.
- R5: Validate the dynamic model of g-LIMIT.
- R6: Characterize the acceleration environment of the MSG.

- NOTE: Deleted requirement
 - » (previously R2): Characterize attenuation of payload-induced accelerations.



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Test Plan Priorities



- Characterize system properties
 - Stability of standby mode
 - Measure umbilical stiffness
 - Measure range of travel
 - Measure mass and inertia
- Verify functionality of anti-bump control
- Evaluate Central SISO controller isolation performance
- Evaluate Central SISO controller tracking performance
- Evaluate Baseline Multivariable controller isolation performance
- Evaluate Baseline Multivariable controller tracking performance
- Evaluate Central SISO controller disturbance rejection and tracking performance
- Evaluate quasi-steady acceleration measurement
- Evaluate Baseline Multivariable controller disturbance rejection and tracking performance
- Evaluate Alternate controllers for isolation and tracking performance
- Upload redesigned controllers for evaluation of isolation and tracking performance

NOTE: *Deleted disturbance rejection tests and local control tests*



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Characterization Test Plan



Test No.	Test	Description	Duration (hh:mm:ss)	Data (MB)
1	Position Control Test	Position stability; bias estimation	00:10:00	1.74
2	Umbilical Stiffness Test	Estimate umbilical stiffness	00:22:00	3.83
3	Range Test	Measure range of travel	00:13:00	2.62
4	Mass & Inertia Test	Estimate mass properties	00:13:00	2.62
5	Recovery Test	Verify anti-bump function	00:06:00	1.04
6	Acceleration Control Test	stability of accel control	00:01:30	6.05
7	Quiescent Isolation Test	Isolation performance	01:10:00	282.45
8	Disturbance Rejection Test	Disturbance rejection performance	00:45:00	92.48
9	Forced Response Test	Pristine excitation performance	00:20:00	41.10
10	MSG Isolation Test	MSG induced disturbance rejection	01:45:00	92.48
11	Quasi-steady Acceleration Test	Estimation of quasi-steady acceleration	15:00:00	156.60

PR 3

- ⇒ 15 Days of Testing
- ⇒ 5 Hours Run Time Per Day
- ⇒ 11.5 GB Data Collected (Total)

PR 4

- ⇒ 15 Days of Testing
- ⇒ 5 Hours Run Time Per Day
- ⇒ 5.5 GB Data Collected (Total)



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Characterization Test Plan



Day	Data Archived (MB)	Total Execution Time
1	308.68	04:13:00
2	400.74	03:15:00
3	277.44	02:15:00
4	411.02	03:20:00
5	156.6	15:00:00
6	411.02	03:20:00
7	277.44	03:15:00
8	400.74	03:15:00
9	411.02	03:20:00
10	411.02	03:20:00
11	411.02	03:20:00
12	411.02	03:20:00
13	411.02	03:20:00
14	411.02	03:20:00
15	411.02	03:20:00
Total	5520.82	61:13:00